EDUCATION, INNOVATION AND INCOME IN RURAL KENYA

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ABSTRACT

In this paper the relationship between education and smallholder income is analysed. The data base used is the 1974/75 Integrated Rural Survey. It is shown in the paper that education has a strong and significant effect on incomes from regular employment. In turn such income has a strong and significant impact upon smallholder innovation. Finally, it is showed that agricultural innovation has a strong and significant impact upon farm income. These conclusions imply that the rural economy gains from interaction with the urban economy through access to employment opportunities. Rural education, whilst perhaps not directly productive in the rural economy, plays the important role of influencing the distribution of access to employment opportunities.

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1. INTRODUCTION

Kenya has been among the most successful of African countries in the development of smallholder agriculture and has also expanded education extremely rapidly. *Prima facie* these two phenomena appear causally connected for there is a tendency for the more educated smallholder households to be relatively prosperous. In this paper we investigate three rival sets of hypotheses which might account for the links between education and smallholder prosperity and in the process identify variables which significantly and powerfully affect smallholder incomes, our data base for testing these hypotheses being the 1974/5 Integrated Rural Survey[1]. The three sets of hypothese are set out below:

Hypothesis 1: Education induces better farming.

Hypothesis 2: Smallholder incomes are determined by land ownership. Education is merely a consumption good.

Hypothesis 3: Smallholder farm incomes are powerfully influenced by the adoption of innovations. The propensity to innovate is powerfully influenced by the availability of regular non-farm earnings from wage employment. Access to regular wage employment is powerfully influenced by education. This hypothesis has recently been advanced by Collier and Lal (1980).

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1. IRS I was a survey of smallholder households using a stratified sample which approached national coverage. Whilst the survey is generally regarded as being reliable the quality of the data is in some cases not very good. Particularly the fact that a considerable number of households (about 7 per cent) report negative incomes is worrying. This reflects the fact that in as much as 20 per cent of the cases the estimated farm operating surplus is negative. This in turn may of course in some cases reflect the real situation. However, negative income households on average have very high consumption and we suspect that in most cases it is due to under-reporting of production. Therefore, before we do the analysis, we exclude all cases where farm operating surplus is negative. We then go on to analyse the remaining 1321 cases.

These three sets of hypotheses have radically different policy implications both for the role of education and for rural development. If (1) is correct then educational expansion is important both for improving income distribution and for raising average income. If (2) is correct, heavy government and private expenditure on education cannot be regarded as investment expenditure, with which it clearly competes for resources. Further, the growth of smallholder incomes post-Independence would be attributed primarily to land reforms. Both an improvement in income distribution and continued growth would hinge upon further land reform. If (3) is correct both re-distribution and growth rest more on the spread of innovations than on land reform. The Collier-Lal thesis is that innovation poses severe problems both of risk and of cash flow which are currently broken by income from regular wage employment and remittances. This raises the prospect that the effect of formal sector employment expansion on rural development is benign rather than malign as suggested by Lipton's "urban bias" thesis. It further suggests that alternative means may be available for breaking risk and cash flow constraints other than by the provision of employment opportunities. Finally, if education is used as a screen by employers and therefore determines access to wage employment, the spread of education will spread opportunities of access and hence improve rural income distribution, but will not increase growth because it will merely re-allocate a given set of employment.

2. The Impact of Education, Innovation and Land upon Farm Income.

Education, if it improves farming, might do so either by enabling farmers to combine given inputs more efficiently or by inducing them to select a better choice of inputs. The former possibility is tested by introducing education into a fitted double-log production function as a technical progress coefficient.

The function that is estimated is:

$$FOS = A\, e^{aEDUC} B^b C^c D^d E^e F^f G^g H^h I^i J^j \qquad (1)$$

where

FOS is equal to the farm operating surplus, EDUC is equal to 0, 1, 2 or 3, depending on the level of education reached by the head of household, 1 representing primary education up to standard 4, 2

representing completed primary education, and 3 representing s secondary education, B - value of purchased inputs, C - opening value of improved livestock, D - number of coffee trees, E - number of tea trees, F - total area under hybrid maize, G - farm size, H - land price per acre, I - family labour, J - hired labour. The small letters represent the coefficients to be estimated. Before the estimation is done the function is converted to

$$\log FOS = \log A + a\ EDUC + b \log B + c \log C + \ldots \text{ etc.} \quad (2)$$

The results of the regressions are given in Table 1. We report the regression for all cases and for the six regional or ecological zone break-downs which have adequate sample sizes. Whilst the r^2 are generally low our concern is not to offer an explanation for the variance in farm incomes but rather to investigate the power and significance of education, innovation and land upon income. Hence, the appropriate criteria are the statistical level of significance of the variables and the size of their coefficients. The first conclusion that emerges is that the educational variable seems to be unimportant for the size of the farm operating surplus. The direct productivity increasing effect of the educational level of the head of the household thus seems to be negligible. It is generally negative and is only once statistically significant.

Land is clearly more important, farm size being highly significant throughout. The land price is generally not significant, which probably reflects the peculiar difficulties of measurement to which this variable was subject.

The elasticity of farm operating surplus with respect to farm size is 0.25 in the national regression, ranging between 0.19 and 0.28 when disaggregated by province and zone. This suggests that whilst land is a constraint upon production it is not the only one by any means.

Whilst the failure of the land price variable to yield a satisfactory proxy for land quality will have tended to reduce the coefficient upon land this does not appear to be a very serious omission. An indication of this is that the coefficient on land

TABLE 1: Dependent Variables: Farm Operating Surplus

Cases	Educ	B	C	D	E	F	G	H	I	J	R^2	Sample Size
All	-.03	.12^{xxx}	.40^{xxx}	.06^{xxx}	.03^{x}	.11^{x}	.25^{xxx}	-.02	-.03	.01	.211	1321
Central Province	-.04	.14^{xxx}	.57^{xxx}	.02	.01	.09	.28^{xxx}		-.04	-.01	.293	230
Nyanza Province	.02	.03	.35	.01	.02	-.01	.14	.18	-.06	.03	.153	228
Westn. Province	-.05	.11^{xx}	.36	.04	.15	.15	.24^{xx}	-.20	.12^{xx}	-.03	.239	231
Tea, West of Rift	n.a	.22^{xxx}	.07	.08^{x}	.03	.08	.19^{xxx}	.15	-.02	.03	.356	235
Coffee, West of Rift	-.13^{xx}	.03	.47^{xxx}	.08	.10	.25	.28^{xxx}	-.36^{xx}			.216	233
Coffee, East of Rift	n.a.	.13^{xxx}	.43^{xxx}	.01		.08	.02	-.06	-.09^{xx}	.04	.134	235

xxx = significant at the 1% level
xx = " " " 5%
x = " " " 10%

size in Central Province, at 0.28, is very close to the national coefficient. Yet Central Province is an area of relatively homogenous land quality and is very densely populated.

As characteristics of innovation we take the value of purchased inputs, the number of improved livestock, the number of coffee trees, the number of tea trees and the adoption of hybrid maize, each entered separately into the regression. Of these, purchased inputs and improved livestock are highly significant, both at the national level and in half of the provincial or zonal disaggregations. Coffee is also significant at the 1% level on the national data but not generally when disaggregated. Tea is significant only at the 10% level nationally and in the tea zones. Hybrid maize is significant only at the 10% level nationally but not significant when disaggregated. At the national level the collective elasticity of farm operating surplus with respect to the five innovation variables is 0.72. This must surely overstate the contribution of innovations. In particular the insignificant coefficient on the labour inputs in the regressions probably reflect that much of the variation in labour input is predetermined by the cropping and livestock choice. Thus, improved livestock and coffee for example both require a much larger labour input than for an equivalent sized farm growing maize yet the extra output generated by this labour input might be picked up directly by the crop coefficients. However, the conclusion that innovation has a powerful influence upon farm income seems hard to escape. As measured, an increase in innovation has around three times as large an impact upon farm incomes as an equal percentage increase in land. Even though part of this reflects greater labour absorption, in an economy in which the rural labour supply is growing very rapidly, that itself is not without importance.

3. The Impact of Education and Wages upon Innovation.

Having established that innovation is a most powerful influence upon farm incomes we now investigate two potentially powerful influences upon the propensity to adopt innovations. Whilst education appears to have no significant effect upon the ability to combine chosen inputs it might still be important

through improving the ability to choose inputs. An alternative thesis (hypothesis 3) is that because of the risks and cash flow problems associated with innovation a secure non-farm source of income such as is provided by income from regular wage employment will be a powerful influence.

We adopt as indicators of innovation, the three innovation variables which were found to have a powerful and significant effect on farm incomes, namely the value of purchased inputs, the number of coffee trees on the farm, and the opening count of improved livestock.

The educational variable is specified as before, while the cash flow is made up of incomes from regular employment (REGEMP), incomes from casual employment (CASEMP), and transfers received (TRANSREC). The latter variable incorporates remittances from relatives, for example a husband, who lives away from the farm. A husband living away from the farm is not considered to be a member of the family as defined in IRS 1. Incomes from regular and casual labour thus measure incomes to members who actually reside on the farm.

The first set of regressions concerns the value of purchases inputs, the results being shown in Table 2. Since this is a fairly general measure it is of relevance to all areas. Taking first the regression on all cases, income from regular employment, transfers received and the two lower levels of education, are all highly significant explanatory variables. For the regional or zonal breakdowns incomes from regular employment is significant at the 1% or 5% level in five out of the six cases and transfer income is significant in two cases. However, the education dummy variable for partial primary education is significant in only one of the six cases and that for completed primary education in two. Secondary education is never significant.

The coefficient upon regular employment income ranges from .051 to .106 indicating that somewhere between 5% and 10% of regular wage income is invested in purchased farm inputs. In those areas where it is significant (Central Province and Coffee East of the Rift Valley) transfer income has an even higher

TABLE 2: Dependent Variable: Value of Purchased Inputs

	REGEMP	CASEMP	TRANSREC	CONS-TANT	EDUC 1	EDUC 2	EDUC 3	R^2
All	.055^{xxx}	-.049	.040^{xx}	192	165^{xxx}	213^{xxx}	80	.058
Central Province	.051^{xxx}	-.037	.121^{xxx}	313	14	405^{xxx}	74	.197
Nyanza Province	.104^{xxx}	.163	.064	60	581^{xxx}	234		.091
Western Province	.106^{xxx}	-.026	.010	128	-10	15	-93	.161
Tea, West of Rift	.028	-.098	.071	338	18	197	150	.041
Coffee, West of Rift	.077^{xx}	-.079	-.017	235	153	-36		.027
Coffee, East of Rift	.058^{xxx}		.123^{xxx}	231	13	242^{xx}		.164

coefficient (.123 and .121) suggesting around a 12% rate of investment in purchased inputs. Transfer incomes are far higher in Central Province than in other areas which may partly explain the lack of significance elsewhere.

The coefficient upon education is high in those cases in which it is significant. However, it is hard to interpret these results as indicating a powerful link from education to innovation. In Western Province, educationally as advanced as Central Province the education coefficients are not significant (and in two of the three cases have negative signs), in Nyanza only partial primary education is significant, in Central Province only completed primary. It is possible that secondary education is insignificant because of the "truncation problem", only a small and perhaps biased proportion of secondary school leavers staying in smallholdings. However, the data is not encouraging for the impact of educational expansion upon output.

In the next set of regressions, reported in Table 3, we use the number of coffee trees on the farm as the dependent variable. In the regression on all cases all the income variables are significant, while none of the educational variables is significant. Among the provinces and zones since the coffee tree cannot be grown everywhere one would not expect the results to be very good outside the main coffee growing areas. Regular employment and transfers are both highly significant in three of the six cases. Income from casual employment is never significant. Education seems to matter very little. Secondary education is always insignificant. The two levels of primary education are only significant in one of the six cases in both occasions having a negative sign.

The coefficient on transfer income, ranging between .021 and .048 is again higher than that on regular employment income (.012 - .031).

In our final measure of innovation the number of improved livestock measured in livestock units is the dependent variable, the results being shown in Table 4. In the regression on all cases

TABLE 3: Dependent Variable: Number of Coffee Trees

Cases	RFGEMP	CASEMP	TRANSREC	EDUC 1	EDUC 2	EDUC 3	CONST.	R^2
All	.012^{xxx}	.021^{xx}	.012^{xx}	11.7	15.0	3.1	31.5	.025
Central Province	.031^{xxx}	-.013	.013	-29.9	-78.2	138.0	121.4	.079
Nyanza	.005	-.009	.009	-22.7	5.6	-66.4	47.5	.015
Western Province	.001	-.014	.048^{xxx}	20.4	-13.0	n.a.	-0.3	.125
Tea, West of Rift	.000	-.012	.021^{xxx}	3.4	- 8.5	-16.0	14.7	.037
Coffee, West of Rift	.012^{x}	-.009	.021^{x}	-52.3^{xx}	-45.9^{x}	-32.7	40.0	.055
Coffee, East of Rift	.026^{xxx}		.007		57.7	111.6	144.1	.064

TABLE 4: Dependent Variable: Opening Count of Improved Livestock

Cases	REGEMP	CASEMP	TRANSREC	EDUC 1	EDUC 2	EDUC 3	R^2
All	.000179^{xxx}	-.000498^{xxx}	-.000193^{x}	.711^{xxx}	.410	-.129	.029
Central Province	-.000013	-.000716^{xx}	-.000346^{xx}	.535	1.377^{xx}	.718	.066
Nyanza	.000012	.000284	.000289	1.193^{xxx}	.607	.547	.062
Western Province	.000121^{x}	.000393	-.000047	.358^{x}	.157	-.230	.040
Tea, West of Rift	.000277^{x}	-.001178	-.000508	1.262	.761	-1.015	.044
Coffee, West of Rift	.000048	-.000228	-.000158	.398	-.527	-1.045	.005
Coffee, East of Rift	.000164^{xxx}	-.000148	-.000063	.253		- .114	.112

income from regular employment is highly significant, while incomes from the other sources are significantly negative. Partial primary education is is highly significant but not higher levels. If we consider the provincial and zonal breakdown income from regular employment is significant in three of the six cases while incomes from casual employment and transfers are either insignificant or negative.

Where education is significant its impact is powerful. However, again it is hard to draw encouraging inferences. What for example, can one conclude from the significance of partial primary education in Nyanza when completed primary education (and hence functional literacy) is insignificant.

We may conclude that regular employment income generally has a significant and powerful impact on each of the three indices of innovation which in turn powerfully and significantly affect farm income. Regular employment at the minimum wage prevailing in 1974/75[1] for one member of a smallholder household would nationally be associated with the increases shown in Table 5.

Table 5: Innovation Impact of One Minimum Wage Job 1974/75.

	Increase due to one job	Mean for all smallholders	% increase
Improved livestock	0.71	0.97	53
Coffee trees	34	127	27
Purchased inputs (s.p.a.)	158	185	85

This impact is spread among regions and zones.

No such general conclusion is possible about the impact of education. Most of our results tend to support the view expressed elsewhere (see Hopcraft) that education has little or no impact on innovation. The livestock regressions perhaps permit slightly greater optimism.

4. Regular Employment Income and Education

Having established that regular employment income has a significant and powerful impact upon the propensity to innovate, the final stage in our analysis is to test the hypothesis that education determine the access to the income that a family can earn from regular employment.

1. 240 s.p.m.

The data at hand are far from perfect for this analysis, but the results should in any case give some indication. We do the following linear regression on the IRS 1 data:

$$REGEMP = a + b\ EDUC1 + c\ EDUC2 + d\ EDUC3 \qquad (3)$$

where

REGEMP is equal to household income from regular employment, and EDUC1, EDUC2 and EDUC3 are dummy variables indicating the highest level of education reached by the head of the household. All EDUC-variables are equal to 0 if the head has no education at all; EDUC1 = 1 if the head has 1-4 years of primary education; EDUC2 = 1 if the head has 5-8 years of primary education; EDUC3 = 1 if the head has secondary education.

Of course it is a drawback that there are data only on the education of the head, since regular household income should be a function of the education of all household members. However, it seems reasonable to presume that the household head is the most important income earner in most cases. Our estimates should therefore give some indication of the effect of education on regular employment income.

The results of our regressions are given in Table 6.

TABLE 6: Dependent Variable: Income from Regular Employment (s.p.a.)

Cases	Constant	EDUC 1	EDUC2	EDUC 3	R^2
All	288	219^{x}	1851^{xxx}	3414^{xxx}	.138
Central Prov.	486	148	3042^{xxx}	2769^{xxx}	.131
Nyanza	311	109	1618^{xxx}	3472^{xxx}	.154
Western Prov.	94	164	1249^{xxx}	2128^{xxx}	.147
Tea, West of Rift	362	234	3503^{xxx}	6465^{xxx}	.313
Coffee, West of Rift	164	n.a.	1271^{xxx}	-164	.096
Coffee, East of Rift	486	242	2140^{xxx}	4078^{xxx}	.117

Taking first the regression on all cases, we find that the regular wage income of families where the head has no education is 288 shillings per year; when the head has partial primary education earnings rise on the average to 288 + 219 = 507; with completed primary education earnings rise to 288 + 1851 = 2139; and with secondary education regular income is 288 + 3414 = 3702 spm. Regular incomes thus increase rapidly with the level of education attained.

When we consider the results at the regional and zonal level we find that whilst partial primary education is significant in only one of the six cases completed primary education is always significant at the 1% level and secondary education, insignificant in all 28 previous regressions, is now significant at the 1% level in five out of six cases.

Education clearly assists access to regular wage employment, but only at levels of education which are high relative to that possessed by most smallholders.

5. Conclusions

We have shown that education has a str ng and significant effect on incomes from regular employment. In turn such income has a strong and significant impact upon smallholder innovation. Finally, we showed that agricultural innovation has a strong and significant impact upon farm income. An order of magnitude can be estimated for the impact on farm income of one regular wage job at the minimum wage by combining the percentage increases in the three components of innovation shown in Table 5 with the coefficients of innovation on farm income shown in Table 1. The results, given in Table 7, obviously need to be treated cautiously. However, the conclusion that farm income incraases by about a third is not perhaps without interest.

Our findings appear to support the Collier-Lal hypothesis (3) whilst running counter to the theses of land constrained and education constrained growth.

TABLE 7: The Impact of One Regular Wage Job on Farm Income

Innovation	% increase	Coefficient on Income	Percentage Increase in Farm Income
Purchased inputs	85	.12	.10
Coffee trees	27	.06	.02
Improved livestock	53	.40	.21
Total	-	-	.33

The implications of the Collier-Lal hypothesis are that the rural economy gains from interaction with the urban economy through access to employment opportunities. Rural education, whilst not perhaps directly productive in the rural economy, plays the important role of influencing the distribution of access to employment opportunities, and will continue to do so whilst even education is seen by employers as either a useful attribute in itself or an indicator of other abilities.

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1. For a discussion of the role of education in urban recruitment see Bigsten and Collier (1980).